Appendix A.8.10

Galway Bat Radio-tracking Project. Radio tracking studies of lesser horseshoe bat species, May 2015 (Rush & Billington, 2015)

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Greena Ecological Consultancy

Galway Bat Radio-tracking Project

Radio tracking studies of lesser horseshoe bat species, May 2015

Photo by Isobel Abbott

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Contents

Executive summary

Greena Ecological Consultancy was been commissioned by Scott Cawley Ltd to undertake a follow up radio-tracking studies in Galway, Republic of Ireland, to inform the N6 Galway City Transport Project. The study was conducted to obtain information on where the bats roost, breed, forage and the extent of their range in order to be able to determine the potential impacts of the proposed Scheme on the local bat populations. A baseline survey has previously been conducted in August and September 2014; however, spring session was not included due to the timing of agreements and permissions necessary for the work. This survey was; therefore carried out in order to provide a full picture of bat activity in the area throughout the year.

No previous radio-tracking study covering Lesser horseshoe bats as well as vesper bats had been undertaken in the area of interest prior to 2014. Scott Cawley carried out static monitoring in combination with emergence surveys and roosts inspections prior to the 2014 radio-tracking study in order to provide basic information on bat colonies present in the area of interest. Static monitoring was extended further beyond the duration of the 2014 study to provide additional data for the radio-tracking study proposed for 2015.

This single radio-tracking study was and carried out by Greena Ecological Consultancy in May 2015. This session, together with the results from 2014, aimed to help understand potential seasonal shift in activity patterns of Lesser horseshoe bats while avoiding interference during the most sensitive period of bat life cycle when females give birth and lactate (suckle their young).

Greena Ecological Consultancy captured four Lesser horseshoes *(Rhinolophus hipposideros)* during the May session, all of them females, three recognisably (but not heavily) pregnant, while one female was considered to be born the previous year so has not bred before nether did she show any signs of pregnancy when captured.
All bats were captured in a static mist net stretched over maternity roost entrance. Bats were of good health, weight ranging from 5.9g to 6.3g. Two of the females (Bat 1 and Bat 4 in this study) were captured and radio-tracked during the previous session in 2014 – their rings were identified as fitted by Greena Ecological Consultancy in August 2014. These bats were previously tracked as Bat 8 and Bat 3 respectively in the 2014 first session. Two females (Bat 2 and Bat 3) were not previously fitted with rings, suggesting they were not present in the roost during the summer session of 2014. These females were ringed in May 2015 at the same time all bats subject to this study were fitted with radio-transmitters. Despite efforts to catch Lesser horseshoe bats from previously identified night roosts west of Galway (excluding Coopers Cave), no other catching session was successful and, therefore, only four bats were studied in 2015, and no other bats were captured.

Between 16th May 2015 and 23rd May 2015, bats were tracked wherever they ranged and were found as far south as the Galway harbour and the area of University College Hospital; south of Ballagh in the west, north to Gort an Chalaidh Angliham and partially across the southern part of Lough Corrib and north of Coolagh in the east.

During the spring session, LHS foraged up to 3.56km from their roost, considerably less then was recorded later in the season in 2014, with majority of bats utilising the immediate area of

Menlo Castle, Menlough village and Menlo Woods. Hedgerow systems in Coolagh area as well as the area of woodland south of Menlough village were very popular. All four bats were utilising similar are for foraging; more than 62% of all recorded locations of each bat fell into the same foraging core area.
The west-most record of a LHS occurrence was less than 2km west of Menlo Castle, the north-most record lies 3.1km away from the roost. Surprisingly, LHS did not avoid Galway City and the south extreme of the overall foraging area was located 3.59km south of Menlo Castle. The eastern edge of foraging areas was located 1.56km away from the maternity roost.

Very limited number of night roosts were found during the 2015 radio-tracking session, majority of bats were returning back to Menlo Castle, their original roost, each night after foraging. The only exception was Bat 3, night- and day-roosting several days in a boulder field before returning back to day-roost in the castle. Bat 2 was also recorded to utilise a natural limestone formation for night-and day-roosting later in the due course of the radio-tracking study.

Bats were foraging in adverse weather and did not seem to be influenced by rain or strong wind. The weather conditions in May were mainly wet and this may have influenced the extent of the overall foraging area. The foraging area was generally smaller than recorded in August and September 2014 and all bats were recorded to forage in a core area largely overlapping between the studied females.

All bats in May session displayed foraging behaviour for two to three hours after dusk most of the nights, after that they returned to roosts or found a night roost where they spent a large part of the night. This behaviour was clearly associated with the sudden drop in temperature in the early evening and further decrease throughout the night.

1.0 Aims and Objectives

The overall aim of the study was to effectively preserve the availability of foraging areas, flight routes and roosting sites of bats and to provide detailed information to inform the project.

The objectives of this study were to identify the principal feeding areas and commuting routes of the main known Lesser horseshoe maternity colony in the Galway area, and to determine the night and day roosts used. While studies in 2014 aimed to gain information during the peak maternity roosting period and pre-hibernation behaviour of Lesser horseshoe bats, the study carried out in spring 2015 aimed to add to the complete picture of bat activity in the study area throughout the year. The radio tracking sessions carried out during the bat active season of 2014 and 2015, whilst avoiding the sensitive period of late stages of pregnancy, birth and first emergence of newly born bats, aimed to form an understanding of seasonal shifts in foraging areas and commuting routes of Lesser horseshoe bats in the Galway area depending on prey availability.

Special attention was paid to the area of the proposed development, in order to accurately and correctly assess the potential impacts of the development on this species.

Main objectives can be summarised as:

- Trapping within the study area to catch and radio tag Lesser horseshoe bats and a follow-up radio-tracking survey in order to provide an understanding of foraging areas and/or commuting routes, either to foraging areas or to other night/satellite/day roosts.
- Processing the data to determine proportional use of different sites and compilation of maps of roosts, foraging areas and flight routes

This study focused solely on the spring part of bat active season, researching bat foraging behaviour during early pregnancy period of the females captured from the previously confirmed maternity roost in Menlo Castle.

2.0 Background

In Europe there has been a decline in abundance and contraction in the distribution range of several species of bat over the last century. Bats their roosts, foraging habitats and flight routes are protected under the Wildlife Acts 1976 as amended and the European Communities (Birds and Natural Habitats) Regulations 2011. Bats are also protected from disturbance when they are in their roosts, and their roosts are protected even if they are unoccupied.

Where developments have the potential to result in significant effects on the features of European Sites, the Habitats Regulations require a thorough assessment of the implications of the development on the ability of the site to meets its conservation objectives and therefore it integrity.

Lesser horseshoe is one of the most endangered European bat species (Stebbings, 1988) it is an annex II species. It was once widespread and common in most countries of Western and Central Europe, e.g. the Netherlands (Voute, Sluiter & van Heerdt, 1980), south Poland (Kokurewicz, 1990), Germany (Rudolph, 1990) and Switzerland (Stutz & Haffner, 1984). A dramatic population decline occurred in the 1950s and 1960s, which led to the loss of large areas of its former distribution.

Suggested causes for the decline of Lesser Horseshoe population include roost destruction, pesticide contamination of both, prey and roosts, habitat alterations and competition with other bat species (Stebbings, 1988, Kulzer, 1995, Arlettaz, Godat & Meyer, 2000).

Main pressure impacting on Lesser horseshoe bats identified in Ireland include renovation/demolition of buildings used as summer roosts, human disturbance in cave roosts and inundation – a particular issue in Karst caves of Clare / south Galway. (NPWS, 2013)

In order to protect suitable foraging habitat as well as roosting and mating sites, detailed knowledge of population ecology is required.

Linear infrastructures are known to have major negative impact on species and ecosystems dynamics, modifying landscape structure through artificialisation, habitat changes, alteration and fragmentation. (Vandevelde, Bouhours et al., 2014). The construction of roads has the potential to negatively affect bat populations, through loss of roosts, foraging habitats and by severing landscape elements used as commuting routes by bats. Roads create an open space, which some bat species are reluctant to cross. Traffic further increases the barrier effect due to sudden movement, noise, light and the risk of collision. Recent research shows that roads have a major negative impact on bat foraging activity and diversity. (Berthinusses, Altringham, 2011)

Since the 1980s, radio tracking has developed as one of the main techniques for studying many aspects of bat ecology (Kenward, 1992). Advances in transmitter technology have reduced the mass of radio-tags and it is now possible to effectively radio-track even the smallest species of bats without exceeding the justifiable surplus weight transmitters add to the weight of the animal. Researchers (International Berlin Bat Meeting consider bats can at times handle up to 25% of their weight without detriment, depending on sex, breeding status, season.

In the radio-tracking study, we investigated the behaviour of individuals by tracking two or more bats simultaneously. The movements of four bats (three breeding females and one non-breeding female) were examined to record the distribution and behaviour of the populations Lesser horseshoe bats during pre-maternity period of 2015.

3.0 Study area

Galway is a vibrant city in west Ireland, located on the River Corrib between Lough Corrib in the north and Galway Bay.

The main roads intersecting the area include the N59 (Thomas Hynes Road) in north-west, the N6 (Bóthar na dTreabh) in east and the N84 (Headford Road) as well as the N17 (Tuam Road) in north-east.

The city is surrounded by parks, field systems and small woodlands forming ideal foraging habitat for all species of bats. Areas of good habitat consist of Merlin Woods Park in east, Beechwood Park and Castle Park, fields around Castlegar, Ballindooly Lake, field systems and limestone pavement with scrub between Ballindooly and Lough Corrib, Menlo Woods, immediate surroundings of the River Corrib, woodland between Oranswell and Lisheenakeeran, Moycullen Bogs, Lough Inch and Bearna Woods. Galway City centre is built up and lit up in the night; however, the River Corrib forms a suitable commuting corridor and connects good quality

habitats in north with green areas within the city, such as the National University of Ireland (Galway) campus.

The River Corrib forms a natural division line between the west and the east side of the study area. Menlo Castle was not only the main bat roost within the area of interest but also a centre point of large proportion of bat activity.

Several areas within the extent of the project have been classified as habitats of high conservation importance. These include Bearna Woods – a part of Special Area of Conservation (SAC) Galway Bay Complex, Lough Corrib that is SAC as well as Ramsar site and Moycullen Bogs, a natural heritage area. Conservation objectives for Lough Corrib include Lesser horseshoe bats (1303) (NPWS.ie, 2014).

The location of the study area is shown in Figure 1.

Figure 1 Scheme Study area of the N6 Galway City Transport Project

4.0 Methods

A valid licence to carry out bat trapping (licence to catch with harp/mist net/by hand no. C085/2015) and radio tracking (licence to mark no.C004/2015) had been obtained from National Parks and Wildlife Service, Ireland and authorisation to access the land involved was obtained from landowners in advance of commencing fieldwork.
Licence to enter roosts (DER/BAT 2015-24) was also obtained.

Because of working at night, the police were notified of the session of the activities and personnel.

Scott Cawley and Greena Ecological Consultancy reviewed existing data, aerial photographs, maps, and carried out a site visit to determine possible trapping places, first in Menlo Castle, later in previously identified night roosts of Lesser horseshoe bats in the area west of Galway. The area of interest consists of field systems with mature hedgerows and stone walls, a continuous area of limestone pavement with scrub, small areas of woodland and urban areas. The potential for successful catching horseshoes in mist nets and/or harp traps was assessed as being low in the open landscape; however, catching directly from the maternity roost in Menlo Castle proved very productive. A six-metre wide Avinet mist net was set across the entrance to the maternity roost on 16th May 2015. No other trapping attempts within the castle were undertaken. All bats (four LHS in total) were caught while emerging from the roost in the net placed over the roost entrance.
Further at least four bats were present in the roost on the night of catching; however, these bats stopped attempting emergence after they detected the fine netting and the net was removed 2 hours after the first recorded emergence in order not to allow the bats out to feed and so not to negatively affect them..
All captured females were fitted with a 0.35g Holohil radio- transmitter of 7 days battery life. Three out of the four captured bats were recognisably, but not heavily, pregnant. One female was assessed as being last year's juvenile, and had not bred prior to the capture. Two of the four captured females had been ringed in the August 2014 season, the other two females were fitted with aluminium rings during the catching session in May 2015.

The radio tracking study took place between the 16th May and the 23rd May 2015. Two radio-transmitters fell off after this period, the remaining two were not possible to locate possibly they had run out of battery power.

A double bank harp trap was used at Bearna culvert together with shield netting. The culvert at the grid reference of M2477723800 beneath the R336 highway, this had previously been confirmed as a night roost for a single Lesser horseshoe bat; however, no bats were captured at this location on the two trapping nights (17th and 18th May 2015).

Two different approaches to radio tracking bats give different results. Tracking individual bats by at least one surveyor can determine complete behaviour and proportional habitat use; but this is limited to small numbers of animals.
The second approach that was used in these study was to track larger numbers of bats that determines a higher proportion of the overall home range of the local population. Higher sample number of animals increases data gathering on roosting sites, numbers of animals visiting feeding areas and going through corridors.

Table 1 below show details of transmitters used, duration of tag battery is stated in days, bpm is the number of pulse transmissions per minute.

Table 1 Transmitters used during the radio tracking session in May 2015

bat	species	supplier	Tag weight	bpm	duration
1	LHS	Holohil	0.32g	60	7
2	LHS	Holohil	0.32g	60	7
3	LHS	Holohil	0.32g	60	7
4	LHS	Holohil	0.32g	60	7

Radio transmitters were glued between the fur-clipped shoulder blades of the bats a using latex adhesive these come off within 2 weeks of being attached.

Up to four fieldworkers used *Australis 26K* and *Sika UHF* radio receivers with *Yaggi* rigid aerials to track bats. Both receivers are able to automatically scan through different frequencies, which made it possible to search for a number of tagged bats at any time. Omni-directional antennas were used to search for bats by vehicle.
The surveyors carrying out the study were Geoff Billington, Tereza Rush, Isobel Abbott and Daniel Buckley.

Tailor made recording sheets were used to record data and a combination of radio sets and mobile phones were used for two-way communication. Accurate bearings of bat locations were taken from hand held sighting Silva Expedition 54 compasses by two or more surveyor at the time. Bearings of up to 1^0 accuracy were obtained. The data used in this report were obtained by using joint bearings (positive contact) of two or more surveyors at the same time.
Global Positioning Systems were used to increase the speed and accuracy of the surveyors to continuous supply of their location.

From all tagged bats, the following data was recorded:

- Observer location
- Bat ID number
- Triangulation bearings with other surveyor(s)
- Apparent location, route and behaviour
- Roost location and details when located

Whenever bats were commuting from roosts or at their first foraging sites of the evening, they were observed from fixed (often elevated) points chosen where good radio reception was available, or other suitable vantage points viewing between buildings and other obstacles. Where possible surveyors made close approaches to bats, to ascertain the exact foraging area and behaviour or to attempt pursuit if the bat was moving away.

Over survey nights surveyors gradually built up a picture of routes bats use for commuting and of bat foraging areas. Surveyors positioned themselves strategically in the area of roosting sites to determine which direction the bats head away from the roost and move out into the wider survey area.

Location of frequent observation points and number of times that they were used are shown in Table 2 below, all of these points were on public roads.

Table 2 Location of observation points used in May 2015

location	grid reference	number of times used
Menlo Castle	M 28270 28381	5
Menlough Village	M 28852 28492	4
Quarry Road	M 29334 30300	1
Coolagh	M 29583 28167	2
The Mount	M 29583 28167	1
Lackagh Quarry	M 29941 27996	2

Tracking ended either when the fieldwork period ended (which could be up to half an hour before dawn), or when all bats had returned to the roost and were static or poor weather (strong wind, rain or drop of temperature) prevented bats from foraging or make them return early to their roosts.

At the start of each survey night, estimations of environmental conditions were noted: wind strength and direction, rainfall, cloud cover and air temperature measured. Any significant changes in weather throughout the survey period were also noted.

Daytime work included located and verifying roost occupation, recording and plotting out results and investigation of any night roosting sites discovered during the tracking sessions.

Results are presented using the traditional method of minimum convex polygons (MCP). This method is compared with the method of multilateral polygons (MLP) drawn around all confirmed areas or points of occurrence of individual bats.
An animal's home range size, shape, and position are traditionally represented by joining the outermost fixes for that animal to form a minimum convex polygon (Mohr 1947). Outlying fixes (representing rare excursions) may unduly influence the polygon's shape and size to produce a misrepresentation of the space actually used by the animal (McNay et al., 1994). Minimum convex polygons (convex hulls) are an internationally accepted, standard method for estimating species' ranges, particularly in circumstances in which presence-only data are the only kind of spatially explicit data available. One of their main strengths is their simplicity, they are used to make area statements and to assess trends in occupied habitat, and are an important part of the assessment of the conservation status of species; these estimates are, however, biased. The bias increases with sample size, and is affected by the underlying shape of the species habitat, the magnitude of errors in locations, and the spatial and temporal distribution of sampling effort.
The method using MCP often results in much larger and less accurate area coverage. Using MLP is based on minimal area between all confirmed points of animal's occurrence during the radio-tracking session. It is obvious that while MCP overestimates potential occurrence of a

tagged bat, MLP might underestimate this. The difference in results obtained using the traditional method and the method of multilateral polygons are shown on maps of foraging areas.

When habitat is to be lost to development, it appears sensible to slightly over-estimate the real foraging area utilising the method of MCP. Where study determines population dynamics and interaction, MLP is a more suitable approach to take plus adding n relevant features within MCP boundary.

MCP are represented by solid coloured area in maps while MLP are represented by checked overlay.

5.0 Survey constraints

These radio tracking studies were only carried out in short periods of the year so bats may use different areas at other times of year. This limitation is partially resolved through previous studies conducted in 2014, later in the bat active season, resulting in a more complete picture of the behaviour of Lesser horseshoe bat populations in the Galway area.

Only four bats were captured and fitted with transmitters in the May session. At the time of the survey, this was estimated to be approximately 50% of the bats utilising the maternity roost at Menlo Castle. Ideally, more individuals would have been studied; however, the high proportion of overlap in the core foraging area suggests that the main characteristics of Lesser horseshoe foraging behaviour at the given time of the year were covered by the study of the selected four individuals.

The small numbers could be purely caused by the main part of the colony not having returned yet from winter/transition roosts. But also there were recent signs of small fires (e.g. a small group having a barbeque) having been lit in both on the ground under the chimney roost and within 3m of it. These may have caused some bats to move out as at this time of year, making our tracking task more difficult as few bats to catch and tag.

Catching attempts in other, previously identified, roosting structures proved non-productive, catching effective was liable to be very ineffective with multi access buildings. No other bats were captured in the May session despite the fact.
A single untagged Lesser horseshoe was observed to use a night roost in a culvert near Bearna, but with only a single bat a visiting once or twice a night not every night, makes catching extremely difficult.

The amount of gathered data was subject to correctly functioning radio-transmitters. Radio-transmitters may fail or batteries may not last the specified duration. Bats, and in particular in maternity colonies can groom radio-transmitters off. Two bats lost their tags prior to the end of their battery life and within the study period.

Adverse weather conditions and the overall weather trend in early 2015 affected the amount of data collected, too.

Rain, ranging from light drizzle to heavy brief showers occurred during the radio-tracking session. The night temperatures were relatively low on all survey nights; temperature dropped after dusk and continued decreasing throughout the night. Majority of bat activity was only recorded within the first two or three hours after dusk; activity ceased thereafter and bats usually

returned back to their day-roost to spend the rest of the night there. It is considered likely that this is common spring weather pattern and the results from the study are; therefore, very valuable to add to last year's data.

The accuracy of a location determined by taking simultaneous bearings can be affected by habitat structure and may result in biased estimates of observed habitat use. A common source of error is signal bounce. Signal bounce occurs most frequently in undulated terrain where a signal is deflected by a hill, resulting in potential errors. The most effective way to overcome signal bounce during ground tracking is to take many bearings from several different places. When all signals appear to be coming from the same point then there is a good chance that the animal has been located correctly. However, if the signals are coming from a number of different points then signal bounce is likely still occurring (White, Garrott, 1990).

Signal deflection was apparent within Menlo Woods and often in proximity of quarries. It is possible that other areas were also affected to a lesser extent.

6.0 Ethical Review

Existing knowledge of bat population was used to determine that the surveys were necessary and justified. Maternity colony of Lesser horseshoe bats was identified at Menlo Castle and several smaller roosts were located in the area of study.

Bats used for these studies could not be replaced by other species or non-living objects, a sufficient number of bats had to be used to determine the foraging areas and behavioural patterns of the colony as representatively as possible.

Survey techniques were appropriate to the objectives of the project. Radio-tracking is highly effective in determining animal's home range, commuting routes and favoured foraging areas as well as crossing points over man-made barriers in the natural habitat.

Both surveyors of Greena Ecological Consultancy, conducting ring marking and fitting of radio-transmitters, hold Natural England class 1 – 4 personal licences and have extensive experience with marking and tagging Lesser horseshoe bats.

Mist nets were set up either after dark or prepared in daytime and opened after dusk to avoid catching birds. Mist nets were attended at all times.

Where bats were caught in a mist net, they were removed immediately to reduce potential stress. Where harp trap was used, arrangements were made to removed potentially caught animals as soon as practical, though none were caught.
This took place/was attempted during nights of suitable temperature and rainfall free.
The catching period avoided more sensitive seasons such as, as when they emerge from hibernation in early spring, later stage of pregnancy in summer or when newly born young are supported for a couple of weeks in mid summer.

All bats were released unharmed at the point of capture.

Weight of radio-transmitters used for these studies did not exceed 7% of bat body weight in any case. All rings fitted by Greena Ecological Consultancy experienced ringers.

No injuries occurred during trapping sessions, all bats were of good health and did not show any signs of distress when fitted with transmitters (and rings where applicable).

Catching session at Menlo Castle was ceased when it became obvious that four bats were still remaining in the roost after 2 hours, they were aware of the presence of the net and were reluctant to emerge. The decision to cease catching was in line to prioritise welfare of the remaining bats so they could emerge and forage that night.

In most intensive catching sessions at roosts you rarely catch half of the animals present.

7.0 Results

7.1 Previous records

Scott Cawley undertook an extensive survey work in the Galway area prior to the radio-tracking session both for this one in 2015 and previous sessions in 2014.

Static bat detectors were placed in suitable habitat and in expected roosting as well as mating places and along expected commuting routes.

A maternity roost of Lesser horseshoe bats was located in Menlo Castle, where peak count of bats in July 2009 reached 38 individuals and a repeat emergence count on 8th July 2014 revealed 27 individuals. Numerous night roosts (or roosts used on occasional basis by a limited number of bats) were identified mainly in farm buildings and culverts in the study area. Night roosts were usually identified based on an internal structural inspection during which signs of bat presence in form of droppings or feeding remains were found. Scott Cawley identified Lesser horseshoe night / satellite / transition roosts between 3 and 6.5km from Menlo Castle.

An extensive study of Lesser horseshoe bat foraging behaviour in the Galway area was conducted in 2014. The same bat colony was subject to the survey. Night roosts previously used by bats were re-inspected.

Surveyors were already familiar with locations that were less shielded, providing good radio-tracking vantage points in the landscape.

7.2 Weather data

Weather conditions were recorded for all nights of radio tracking. Maximum temperature refers to maximum day temperature while minimum temperature refers to minimum night temperature. The range of temperature recorded during radio tracking is shown as survey temperature. Precipitation was recorded during 24 hours; strength of wind was recorded during survey nights. Weather conditions are provided in Table 3 overleaf.

Table 3 Weather data, May session

Date	Max Temp (°C)	Min Temp (°C)	Survey Temp (°C)	Precipitation (mm)	Wind (B)
16/05/2015	11	8	10 - 8	0.2	4
17/05/2015	13	7	10 - 7	0.4	4
18/05/2015	13	4	8 - 4	0.1	4
19/05/2015	11	4	8 - 4	0.3	4
20/05/2015	10	5	9 - 5	0	3
21/05/2015	14	7	9 - 7	0	3
22/05/2015	14	9	11 - 9	0	3
23/05/2015	17	9	13 - 9	0	2

Data from Worldweatheronline.com, 2014 and survey records

7.3 Bat captures

All Lesser horseshoe bats were captured at Menlo Castle were caught in a six-metre mist net stretched over the entrance to the maternity roost in a chimney.

Two bats from the August session in 2014 were re-captured in May 2015. Their foraging areas could; therefore be compared with the 2014 session.

All bats fitted with radio-transmitters and ringed by Tereza Rush, bat 1 and bat 4 carried rings from previous season, bat 2 and bat 3 were ringed.

Table 4 Captures 16/05/2015, Menlo Castle

Time caught	species	sex	forearm (mm)	net weight (g)	ring number	comments
21:59	LHS	F	36.7	6.1	L01608	Adult, pregnant, **Bat 1,** Ring from 2014
22:16	LHS	F	38.2	5.9	L01691	Adult, not bred, **Bat 2**
22:19	LHS	F	38.6	6.0	L01690	Adult, pregnant, **Bat 3**
22:48	LHS	F	38.3	6.3	L01603	Adult, pregnant, **Bat 4,** Ring from 2014

Abbreviations: **F – female; LHS – Lesser horseshoe *(Rhinolophus hipposideros)***

7.4 Roosting sites

7.4.1 Daytime roosting sites

Three daytime roosting places were identified during the radio-tracking session conducted in May 2015. Table 5 shows details of daytime roosts in this session. Three out of the four captured bats consistently used the maternity roost in Menlo Castle. One of them (bat 3) utilised a roost in a boulder field over several days before returning back to Menlo. Bat 2 moved to a natural limestone structure to roost by the end of the survey session and eventually lost its tag there. All of these daytime roosts were also used in the night for short periods of night roosting, although night roosting followed by extensive periods of foraging activity occurred very rarely during the spring radio-tracking session, compared to extensive night roosting being recorded in August and September 2014.

Table 5 Identified daytime roosts in August 2014

roost	bats using	grid reference	location	description
A	1,2,3,4	M 28491 27872	Menlo Castle	castle wall
B	3	M 29657 27130	Boulder field	Cavity among large boulders
C	2	M 28865 28047	Limestone structure	Cavity

Roost A, Menlo Castle, is shown in Figure 2, roost B, the cavity among large boulders, in Figure 3, and roost C, the large cavity in the natural limestone structure can be seen in Figure 4.

Surprisingly, bat 3 was pregnant, yet did not stay in the maternity roost, possibly suggesting another maternity satellite roost is present. The roost in the boulder field did not appear to be suitable for maternity colony so it points towards bats still not having settled into maternity sites at this time of year in 2015.

though it could not be fully accessed for inspection nor was there access to be able to carry out multiple emergence counts. and an emergence survey carried out to count the number of bats utilising the location only revealed the usage by bat 3. Bat 3 eventually returned to Menlo Castle before the transmitter stopped working.

Menlo Castle was the only roost previously utilised in the 2014 season.

Table 6 below shows usage of daytime roosts by individual bats.

Table 6 Daytime roost usage during the monitored period in May 2015

bat	16/05	17/05	18/05	19/05	20/05	21/05	22/05	23/05	24/05
1	A	A	A	A	A	A	A	N/A	lost tag
2	A	A	A	A	A	A	N/A	N/A	C
3	A	A	B	B	B	B	B	A	A
4	A	A	A	A	A	A	N/A	N/A	N/A

Figure 2 Roost A, Menlo Castle

Figure 3 Roost B, boulder field

Figure 4 Roost C, natural limestone structure

Figure 5 Location of all roosting sites (marked with orange stars) identified in 2015

7.4.2 Night roosting sites

All roosting places identified as daytime roosts were also used as night roosts during the night for short periods of time before further foraging commenced. No night roosting in terms of remaining in the structure between prolonged foraging periods occurred in the spring session.

No roosts only used at night were located in this session.

Foraging period were relatively short in duration and once the temperature dropped each night, bats returned to their roosts and rarely emerged again.

7.5 Foraging periods

All Lesser horseshoe bats radio-tracked in the May session were displaying similar foraging pattern. They emerged approximately 15-20 minutes after sunset and foraged for 2-3 hours before returning to the roost. Due to the night temperature drop, bats rarely re-emerged for further foraging. Very limited activity was recorded after 1.00am each day. Bats emerged to forage even in stronger wind and rain ranging from light drizzle to heavy shower, but temperature appeared to be the limiting factor of foraging behaviour in the spring.

7.6 Foraging areas

Foraging areas for the purpose of this report were expressed in the standard form of minimum convex polygons as well as the form of multi-lateral polygons. Areas have been designated by the use bats made of them as combined areas of roosting sites, commuting and foraging areas of individual bats.

The Lesser horseshoe bat maximum foraging distance from the roost ranged from the immediate surroundings of Menlo Castle up to 3.56km with the average maximum distance of foraging area from the roost being 2.86km. The foraging areas of all studied bats were much less extensive than later in the bat active season, recorded in 2014. This, also, can be explained by the night temperature drop, leaving bats to utilise known close resources.

Table 7 shows a summary of results of the radio tracking session, including the number of fixes taken on each bat and the number of days a positive contact (joint bearings of two or more surveyors) was made.

Table 7 Results of radio tracking session in May 2015

bat	species	sex	foraging area MCP (sq.km)	foraging area MLP (sq.km)	maximum distance from roost (km)	fixes taken	over days
1	LHS	F	6.94	4.61	3.56	38	6
2	LHS	F	5.26	2.62	3.08	70	6
3	LHS	F	6.67	2.52	2.72	71	7
4	LHS	F	1.48	0.07	2.06	21	4

The majority of foraging areas obtained in May overlapped in the Menlo Castle and Menlough Village area, extending further across Menlo Woods; meaning this was a key foraging area. Field systems and quarries north-east and east of Menlo Castle proved to be crucial for Lesser horseshoe bats. This corresponded with the findings of 2014.

The following figures show forging areas (home ranges) of all bats successfully radio-tracked. Shaded area represent MCP traditional method, while checked area represents MLP method. Commuting routes, where they could beconfirmed, are shown with lines, confirmed foraging areas are marked with darker shaded areas.

Figure 6 Foraging area of bat 1

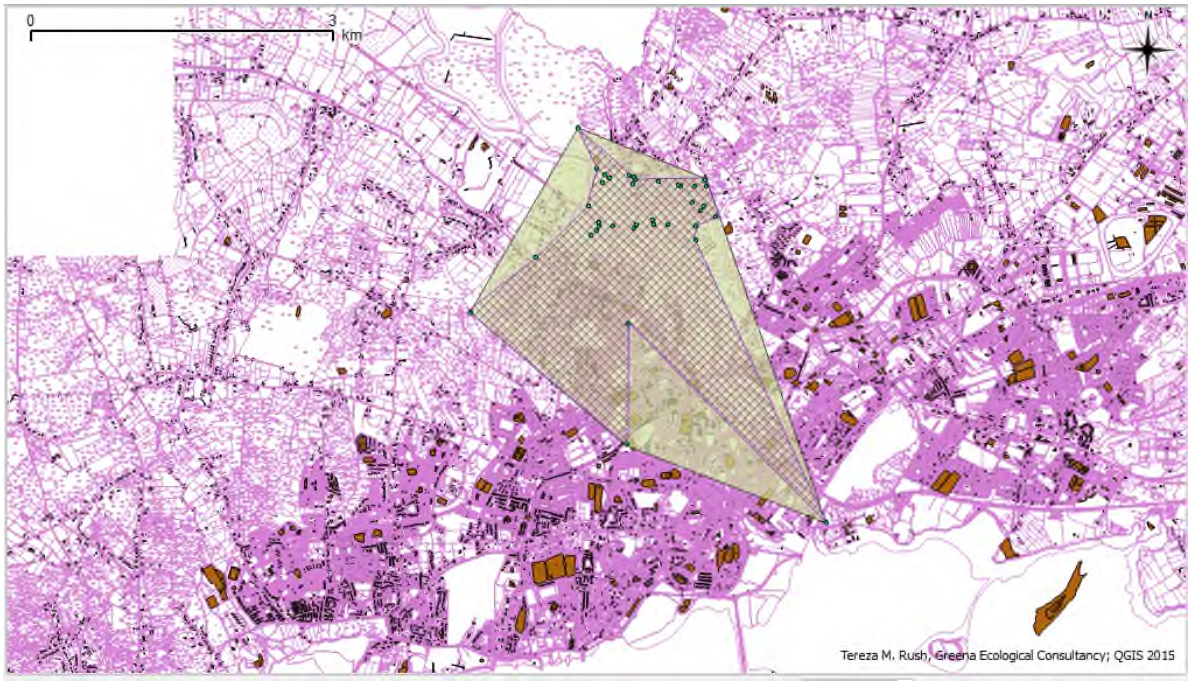

Figure 7 Foraging area of bat 2

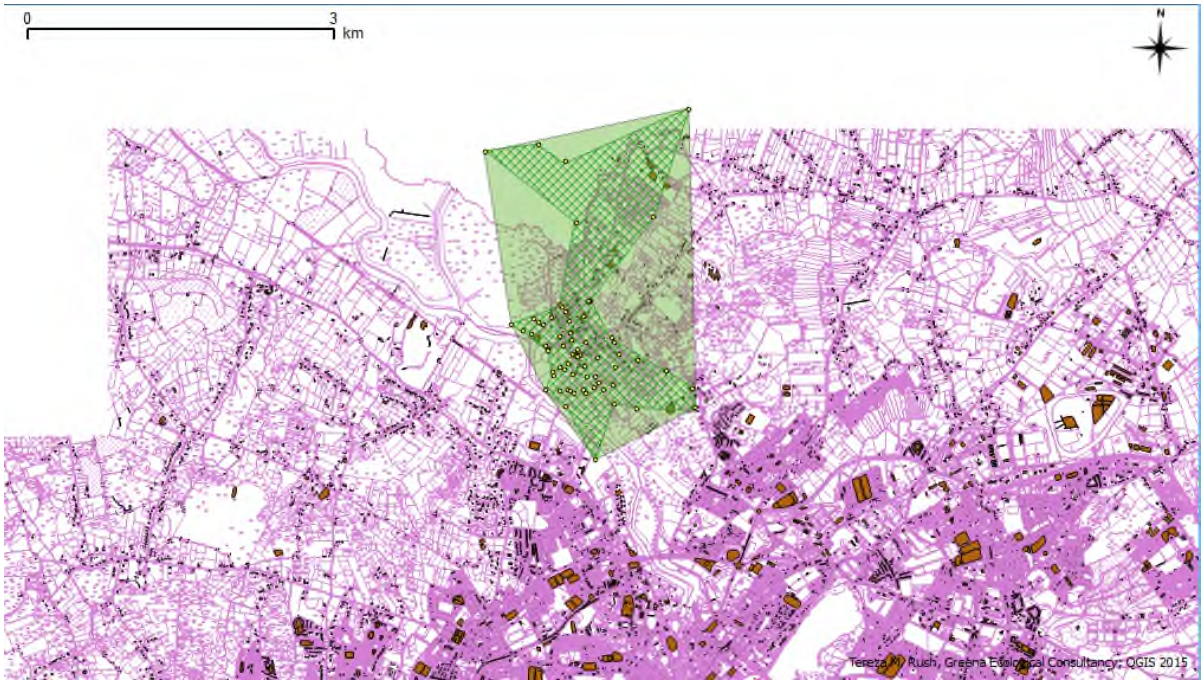

Figure 8 Foraging area of bat 3

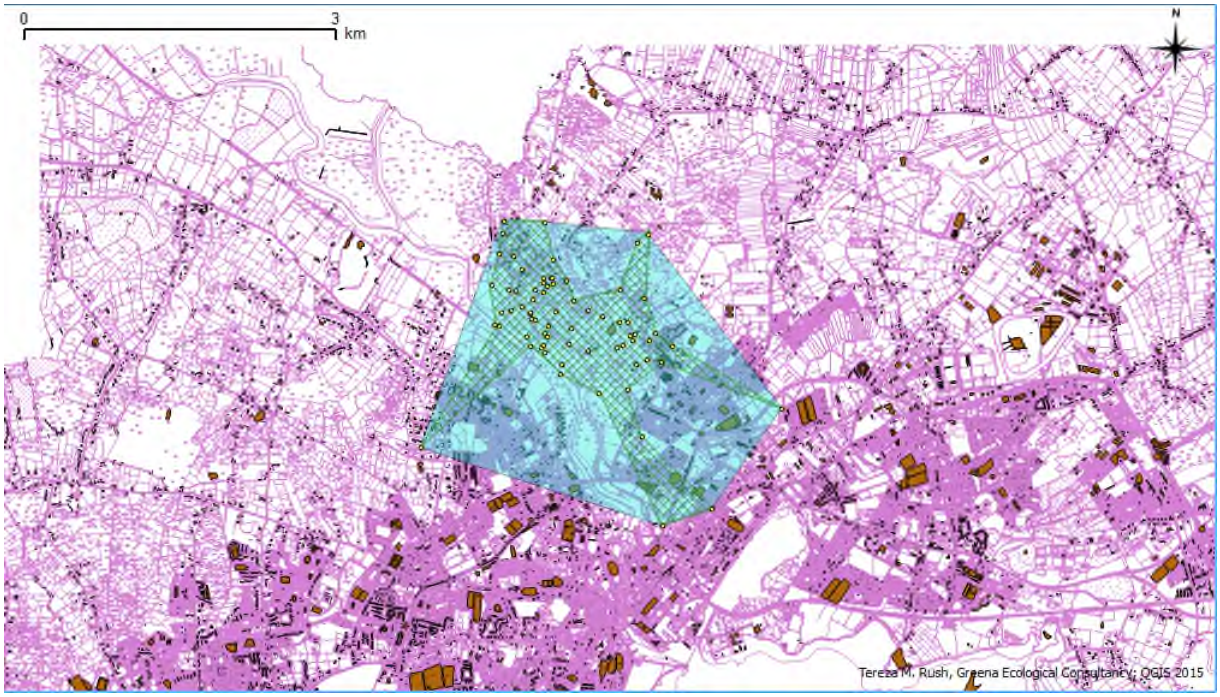

Figure 9 Foraging area of bat 4

Foraging and roosting areas:

Bat 1

Bat 1, a pregnant female Lesser horseshoe, was captured at the maternity roost in Menlo Castle and did not change her roosting place throughout the survey. This bat was previously captured and radio-tracked in 2014 (Bat 8 in the August 2014 session) and did not change roost during the summer study either. Last year this bat utilised a small area in vicinity of Menlo Castle and in Menlo Woods, returning to the roost on regular basis throughout the night suggesting a dependent young to care for. Bat 1 covered the largest foraging area of all bats studied in 2015 – 6.94km^2 in total, and travelled the longest distance from the roost, up to 3.56km. Its foraging area included the core area of Menlo Castle, Menlough Village and Menlo Woods, with 71% of all fixes on this bat located in the core area, but extended south and west across the River Corrib and onto Galway coast. It is likely that Bat 1 followed the River Corrib through Galway city down to Galway harbour.

Bat 2

Bat 2, a young female Lesser horseshoe bat, was captured from the maternity roost at Menlo Castle and continued using the roost for several days into the radio-tracking study, until moving into a new roost in a natural limestone structure in Menlo Woods, north-east of the castle, around the grid reference number of M 28865 28047 on 24th May 2015. This change corresponded with the time Bat 2 lost its tag, which was eventually located near the limestone structure. The foraging area of Bat 2 covered 5.26km^2 and the female travelled up to 3.08km from the roost. 78.6% of all fixes were recorded within the core foraging area of all bats, but also extended north across the southern part of Lough Corrib and towards Gort an Chalaidh Angliham. Bat 2 usually returned to the roost shortly after the night temperature drop.

Bat 3

Bat 3, a pregnant female Lesser horseshoe bat, was captured from the maternity roost in Menlo Castle, but after two days left the roost and spend several days in a new roosting place in the boulder field around grid reference of M 29598 27171, south-east from the castle and south of Coolough Lake. Towards the end of the radio-tracking study, Bat 3 returned to the maternity roost in Menlo Castle before the signal from its transmitter got lost. The foraging area of Bat 3 extended over 6.67 km^2 and the maximum-recorded foraging distance from its roost was 2.72km. Approximately 62% of all fixes on this bat were recorded within the core foraging area of Menlo Castle, Menlough Village and Menlo Woods; however, Bat 3 also foraged to the south-eats and south-west of the core area, covering the northern part of Galway City, Coolough and crossing the River Corrib.

Bat 4

Bat 4, a pregnant female Lesser horseshoe, was captured from the maternity roost in Menlo Castle and did not change her roosting place until 22nd May when her signal was lost. This bat was previously studied in August 2014 (Bat 3 then) when its foraging area covered the limestone pavement and quarries to the north-east of the castle, all the way towards Coil Uachtar Kilroghter. This bat was also known to roost in the quarries for prolonged periods of time. Bat 4 was considered to have a dependent young in the maternity roost in Menlo Castle in 2014.

Only limited data were collected on this bat in 2015, it was difficult to locate during the survey nights and the signal was lost before the end of the radio-tracking session. This may be due to a fault in the transmitter or due to the fact that Bat 4 covered large distances in the night and was regularly leaving the study area. The recorded foraging area extended over 1.48 km^2 with the maximum recorded foraging distance of 2.06km from the maternity roost. 71.4% of all recorded fixes on this bat fell into the core foraging area of all studied bats, but Bat 4 also ventured north and north-west of the Castle, crossing the River Corrib and foraging along the southern coast of Lough Corrib.

Figure 10 shows the combined overall foraging areas for all horseshoe bats in May 2015, Figure 11 depicts the extent of the core foraging area of all studied bats. The overall foraging area of all bats covered 16 km^2 (MCP – shaded in Figure 10) or 10.22 km^2 (MLP – checked in Figure 10). The core foraging area of all bats extended over 1.25 km^2.

Figure 10 Overall foraging area in May 2015

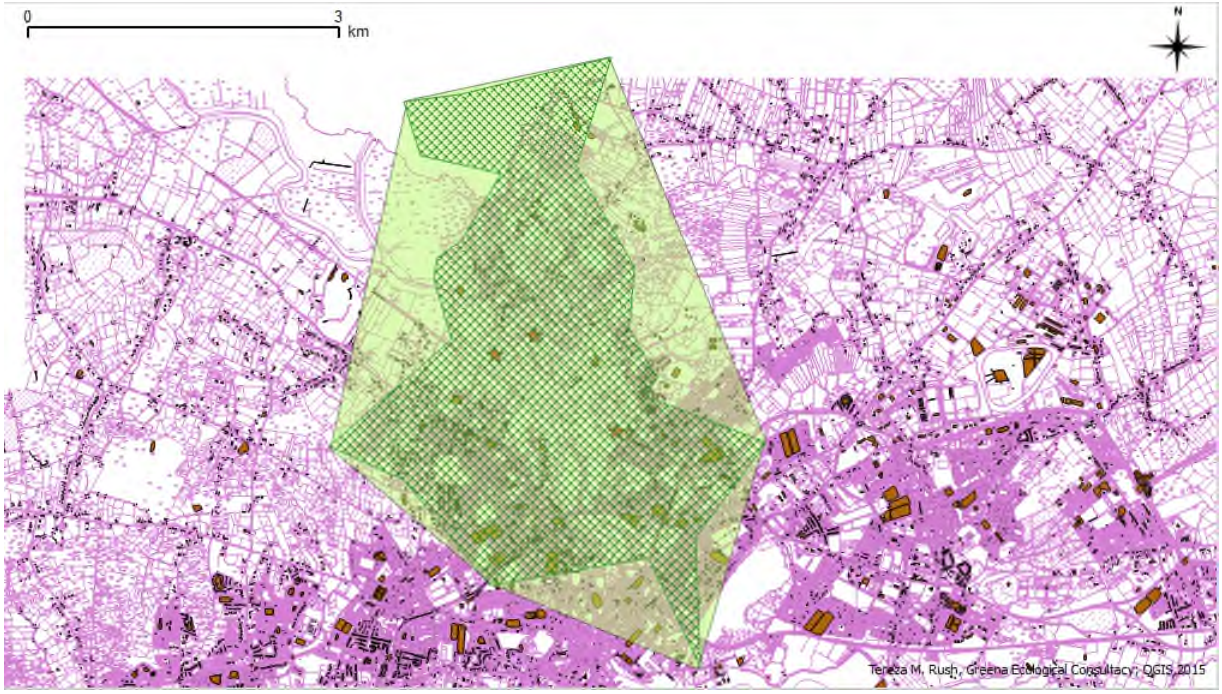

Figure 11 Core foraging area in May 2015

7.7 Summary of Results

Greena Ecological Consultancy carried out an additional radio-tracking session in Galway in 2015 in order to complete the full picture of bat activity in the area throughout the year. Previous sessions covered the summer maternity season and the autumn pre-hibernation activity and took place between late July and August, followed by the second one commencing in late August and is extending into September 2014.

Four Lesser horseshoe bats, all females, were captured and fitted with radio-transmitters. All bats were caught at the known maternity roost at Menlo Castle. Further four or five bats were present in the roost on the night of catching but these could not be part of the study to preserve welfare of the colony.

No other bats were captured from Menlo Castle neither other locations in May 2015.

Two of the females captured in May 2015 were previously studied in August 2014 and the results from 2015 provided an interesting comparison of foraging activity of these individuals.

No juvenile bats were subject to survey carried out by Greena Ecological Consultancy. Three of the studied female bats were recognisably, but not heavily, pregnant; one bat was considered to be a young from 2014 that did not show any signs of pregnancy at the time of the capture on 16th May 2015.

Majority of foraging areas of all studied Lesser horseshoe bats overlapped in the area of Menlo castle, Menlo Woods and Menlough village. This was considered to be the core foraging area from where bats travelled both, north towards Lough Corrib and south following the River Corrib

all the way to the coast of Galway. Bat foraging area was smaller than recorded in the previous year. It is likely that the obvious night temperature drop was to blame for shorter foraging periods and shorter travel distances of all studied bat in spring 2015.

Only three roosts of Lesser horseshoe bats were confirmed during the May 2015 study. These included the maternity roost of Menlo Castle and two new sites, not utilised by bats in the radio-tracking studies of 2014. The new roosting sites included a boulder field with large gaps among the boulders around the grid reference of M 29598 27171 and a natural limestone structure located at the grid reference of M 28865 28047.

Night roosting was common in the summer and autumn sessions in 2014 but rarely occurred in the spring session in May 2015. Bats usually foraged for 2 – 3 hours after dusk, then returned into their roosts to remain there for the rest of the night, perhaps due to low night temperatures. When further foraging occurred, it was only brief and in vicinity of the roosting places. For this reason all located roosts could also be considered night roosts.

Lesser horseshoe bat maximum foraging distance from the roost was 3.56km in May 2015, much less comparing too both, summer and autumn session of 2014. The average maximum foraging distance of bats in this study was 2.86km from the roost.

The importance of the maternity roost in Menlo Castle as well as the immediate area of Menlough Village and Menlo Woods was highlighted in this study, reinforcing the results of previous sessions.

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